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SVENSKA SKIFFEROLJEAKTIEBOLAGET, ÖREBRO

A DEVICE FOR SUPPLYING HEAT OF GASIFICATION TO TUBULAR CASINGS INSERTED IN A SHALE ROCK AND SEALED AGAINST THE ROCK

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The present invention refers to devices for the *in situ* extraction of oil from shale rock. When using these, heat of gasification is supplied to tubular casings inserted in the rock. Hot gases are used as the heating medium in this process, and the gases are wholly or partially produced through combustion within the casing inserted in the shale rock.

When transferring heat to a shale rock in this manner it is of importance that the supplying of heat can be properly adjusted. If, for example, there is limestone overlaid on the shale rock, then the heating shall mainly benefit the shale rock, whereas as little heat as possible should be wasted on heating the overlaid stratum of lime which does not emit any oil-producing

gases. It is further of importance that the heat transfer from the casing, which is often very long, to the shale rock become as homogeneous as possible along the entire part of the casing that is surrounded by the shale. In practice one then has to work within relatively narrow temperature limits in order to obtain a reasonable extraction of the oil products on the one hand and prevent a harmful overheating of the same and detrimental attacks on the casing by certain gases formed in the shale, respectively, on the other hand. With these observations as a basis the present invention is essentially characterized by the fact that in the tubular casing partly at least one gas-conducting tube and partly at least one air-conducting tube are installed, of which the gas-tube or tubes have outlets placed on different levels with respect to one another within the portion of the casing that is surrounded by shale rock, and that the air-tube is inserted into the casing to the lower portion of this and has outlets at said portion, so that several combustion zones are created along said portion of the casing when the gas is combusted.

The invention will be more thoroughly described below with reference to the designs shown in examples on the enclosed drawing, at which time other qualities characteristic of the invention will also be mentioned.

A longitudinal section of a casing inserted through the shale rock and equipped with devices according to the invention is shown in Figure 1.

A diagram indicating the temperature distribution in the vertical extent of the casing is shown in Figure 2.

A modified design according to the invention in a section similar to the one in Figure 1 is shown in Figure 3.

In the drawing, 10 indicates a tubular casing, possibly consisting of several portions joined together, preferably of metal, which is inserted into a drill hole that extends through

the shale rock. The casing is closed at the bottom, so that its interior is separated from the rock. Between the casing and the drill hole there is an interspace that is filled with a powdery or granular material as indicated by 11.

It should be particularly mentioned that the casings 10 are represented in the figures in different scale vertically and laterally. Accordingly, they are often in reality 20 m long, for example, while their diameter might be only twice that shown in the drawing.

The casing 10 is equipped with an inlet 12 for compressed air, which moves to a tubular air channel 14 that extends downwards along the entire casing to its lower end. Another tubular channel 16 (Figure 1) is through its inlet opening 18 supplied with combustion gas under a suitable pressure. The tube channel 16 also extends from the top downwards to the lower portion of casing 10. The tubular channel 14 will in the following be called the air-tube and the tubular channel 16 the gas-tube. Both tubes are made of a suitable metal. The gas-tube is preferably equipped with several gas openings 20 which are situated on different levels, and through which the gas flows out to burn after ignition by means of the combustion air conducted through the air-tube in the inner portion of casing 10. The combustion gases produced during the combustion leave through an outlet opening 22 in a hood 24 installed in the upper portion of the casing, from where they can be conducted out into the atmosphere through suitable channels.

The air-tube 14 is sealed against the hood 24 by means of a bushing 26 that insulates electrically. In addition, the air-tube 14 is connected by means of an electric conductor 28 to the gas-tube 16 which in turn is connected in an electrically conductive manner to the hood 24. Then, if the air-tube 14 at 30 and the hood 24 at 32 are connected to an electrical transformer or the like, an electric current will pass the air-tube 14, the connective conductor 28 and the gas-tube 16.

The tubes 14 and 16 that form an electrical resistance are first heated in this manner with electric current when the heating according to the invention is to be started. Owing to this, the air and the gas flowing in through the respective tubes are heated, so that an ignition comes about, after which the heating process gets started. After that the electric source of current supply can be disconnected.

The highest temperature in a gas flame exists in a zone in the upper portion of the flame. If the gas-tube 16 is only equipped with an opening in the base portion of the casing 10, an intensive heat is created here, which, to the extent the combustion gases flow upwards, gradually decreases, while heat is transferred to the surrounding shale rock. However, it is of great importance that the shale rock becomes at least almost equally heated in the lower portions and the upper portions, for example as indicated by the temperature curve 34 in Figure 2, the distance of which from line 36 indicates the temperatures at different depths in the rock. The covers of limestone 38 and soil 39 on top of the shale, on the other hand, get a lower temperature, as shown by the curve.

In order to achieve such a distribution of the temperature in the shale rock and the limestone, during which the temperature in the former rock must in addition be kept within temperature limits that are suitable for a reasonable extraction of high-quality oil products, the gas is now conducted to the casing through the gas openings 20, situated on different levels. During the upward flow of the combustion air new gas is supplied in this manner to the extent that the combustion gases cool during the supplying of heat to the shale rock. In the portion of the casing 10 that is surrounded by the limestone gas openings 20 are missing in the gas tube 16, and consequently no reheating of gases occurs here, which is why the temperature of the gases is lower when they pass this part of the casing. In this manner

the shale rock is given a higher, relatively evenly distributed temperature according to the invention, while the limestone is heated to a considerably smaller degree.

The air-tube 14 can have the same design as the gas-tube 16 and consequently be equipped with a number of openings 20 on different levels. In this way the two tubes can exchange functions with one another, so that they alternately are connected to the gas-supply pipes and the air-supply pipes, respectively, by means of suitable valve arrangements. The air is forced in under a higher pressure than the gas, and in this process the relative gas volumes, the smaller for the gas and the larger for the air, are adjusted in a suitable manner to guarantee satisfactory combustion.

The device just described has the advantage that if the tube that the gas has flowed through for a certain period of time is subjected to coke deposits through cracking of the gas because of the high temperature of the tube wall, then such a coke deposit will be burnt away during the following period when the tube has combustion air flowing through. The supply channels to the inner of the casing are thus kept free from coke deposits that clog. However, before the gas is brought into the gas-tube 16 it can through suitable preparation in a way known in gas technique be given such a composition that it does not deposit coke. In such a case the gas-tubes and the air-tubes can have the design shown in Figure 1.

The electrical heating at the beginning of the heating process according to the invention can be achieved or facilitated by the lower end of either the gas-tube or the air-tube being made from a thinner material, as indicated by 40. In the thin part of the tube a sufficient electrical resistance arises to heat the gas to ignition temperature. Alternatively, a separate electrical resistance can be installed for the

ignition of the gas, and this resistance can be placed at the connector wire 28, for example.

With the design according to Figure 3 a number, in the present case three, of supply tubes 42, 44 and 46 are installed in the casing 10. These tubes are of different lengths and are made with gas outlets 20 at the bottom, which are thus situated on different levels. The design according to Figure 3 allows the gas supply to each of the different openings 20 to be regulated from outside by means of suitable valve mechanisms. Other parts in Figure 3 can be made in the manner described above in connection with Figure 1.

The invention is naturally not limited to the ways of implementation shown but can be varied in several respects within the framework of the following patent claims. The combustion gas required for the carrying out of the heating process can with advantage wholly or partially consist of the gaseous products that are obtained besides oil from the shale rock. The process of extracting oil thus becomes wholly or partially self-supporting with regard to fuel.

## Patent claims

1. A device for supplying heat of gasification to tubular casings inserted in a shale rock and sealed against the rock, characterised by that at least one gas-conducting and at least one air-conducting tube are mounted in a casing of which the gas-tube or tubes have outlets arranged on different levels within the portion of the casing that is surrounded by the shale rock, and that the air-tube is drawn into the casing down to the lower portion of the casing and is provided with outlets at said portion, whereby a plurality of combustion zones are created along said portion of the casing in the combustion of the gas.

2. A divice as claimed in claim 1, characterised by that the gas and air-tubes are shaped alike and adapted to be connected alternately to gas and air supply lines, positioned outwardly of the casing, by means of valves or the like.

3. A device as claimed in claim 1 or 2, characterised by that the gas and/or air tubes are adapted to serve as conductors for the electrical current used for the ignition of the gas down in the casing.

4. A device as claimed in claim 1, characterised by that a number of gas tubes of different length are inserted in the surrounding casing and in their lower ends are provided with openings for conducting the gas into the casing.

Fig.3 Fig.1